Flight-Qualifiable, Three-Point Docking Mechanism Control Electronics for Automated Docking

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The control electronics (fig. 111) are an instrumental part of the three-point docking mechanism (fig. 112). They provide power and control to the latches and status to a vehicle's onboard computer. This three-point

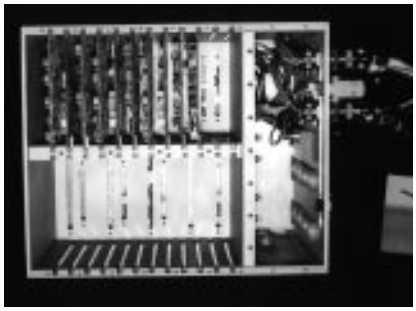

FIGURE 111.—Three-point docking mechanism controller (one string of electronics showing).

docking mechanism is one of the flight-qualifiable systems that make up the automated rendezvous and capture system, and the objective of the controller is to provide for autonomous docking with a target vehicle. The latest three-point docking mechanism design (third generation) includes three-phase, brushless, direct-current motors; two-phase, brushless resolvers; and trunnion presence sensors. Electronically, this is radically different from previous versions of the mechanism. As a result, a new electronic design was developed to control the latches. Another aspect of the new design is the inclusion of redundant motors, resolvers, and sensors. The redundancy is included in the controller design as two single strings of electronics.

The motors are driven by a Metal Oxide Semiconductor Field Effect Transistor inverter using a six-step technique. Hall-effect devices are used for motor commutation. The resolvers are used to provide position for set-point monitoring and derived velocity for closed-loop rate feedback control. Logic has been developed that uses the presence sensors (infrared light-emitting diodes and frequency-matched phototransistors) to determine the presence, as well as direction of movement, of the trunnions in the capture envelope. Requirements placed on the mechanism are to capture a "docking trunnion" within 3 seconds and then close to alignment position in about 20 seconds or longer (about 4.5 millimeters per second of trunnion movement). The controller has pre-established capture and closing rates and selects which rate to command based on the position of the latch's fingers. Using the presence sensors, the control electronics, when armed, waits until two of the three trunnions are in the capture envelopes of the latches before initiating capture. Before the latches close to full dock, all three must be at the "alignment" position. The controller receives "high-level" commands from a remote source, such as an onboard computer, through an RS–422 interface. These commands can be used to do a precheck of the latches, arm the controller for automated capture, or override the automation and force the latches to open either in normal rate or emergency rate if required. The controller also sends out sensor status, latch position status, and engineering data such as motor current, rate command, rate feedback, and resolver position to the onboard computer. These data can be used by the computer to perform redundancy management. As part of the redundancy of the controller, the presence sensors of both sides are always active so that either side of electronics has knowledge of trunnion presence in the case that control must be switched over to the other side. The three-point docking mechanism system has already been baselined for such future flight applications as the space station resupply module and possible future satellite servicer vehicles.

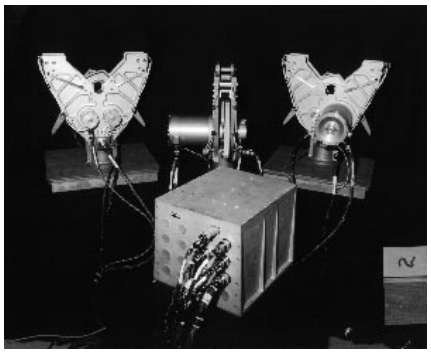

FIGURE 112.—Three-point docking mechanism system with latches, cables, and controller.

Reference: MSFC–SPEC–2483

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